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# Status of the MOD07 atmospheric profile algorithm

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# Outlines

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- Collection 6 algorithm updates
- Validation
  - H<sub>2</sub>O/CO<sub>2</sub> channels spectral shifts
  - Effect of emissivity
  - Surface air Temperature
  - Local comparison of TPW and TOZ
  - Global comparisons with TOMS/OMI, AIRS
- Conclusion and Future Plans

# MOD07 algorithm updates for Collection 6

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- Update the radiative transfer model to CRTM (from prototype CRTM)
- Remove TPW based bias adjustment in the final TPW product
- Apply H<sub>2</sub>O/CO<sub>2</sub> channel spectral shifts for Aqua (Tobin et al., 2006, JGR)
- Update Nedr for both Terra and Aqua
- Update surface emissivity spectra to the current version In the training database
- Make the Aqua and Terra DAAC code uniform
- Modify definition of TPW low and TPW high to enable calculation of 3 layer water vapor means. The new layers are: (Low) sfc-680 and (high) 440-Top (10hPa)
- Improve QA/QC flags, QA usefulness and Confidence flag bug is fixed
- Update output file: adding offset/scale factor usage, list of pressure levels, K-index valid range fixed, surface temperature changed to skin temperature, mixing ratio profile

# The surface characterization in the training dataset

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- **Skin temperature** – empirical relationship between  $T_{surf}$  and  $T_{skin}$  based on IR Thermometer measurements at 3 Cart Sites
- **IR surface emissivity** over land - Baseline Fit Approach

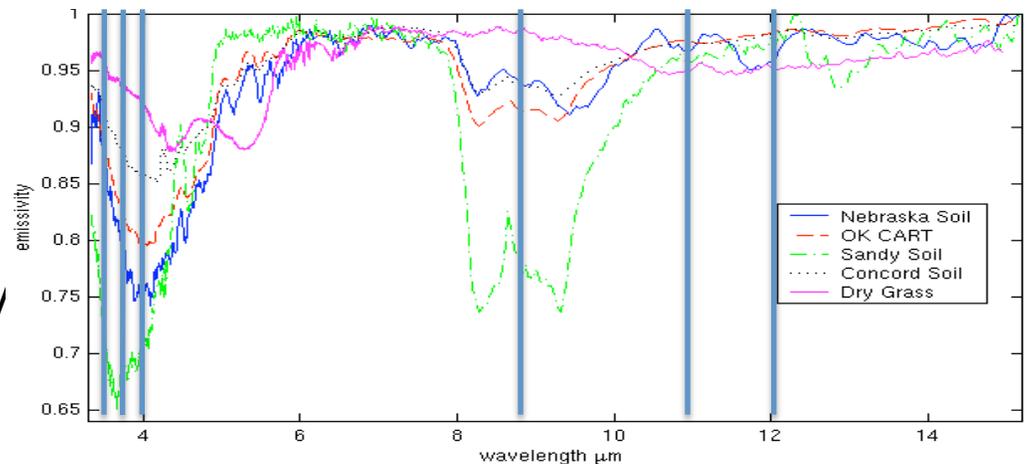
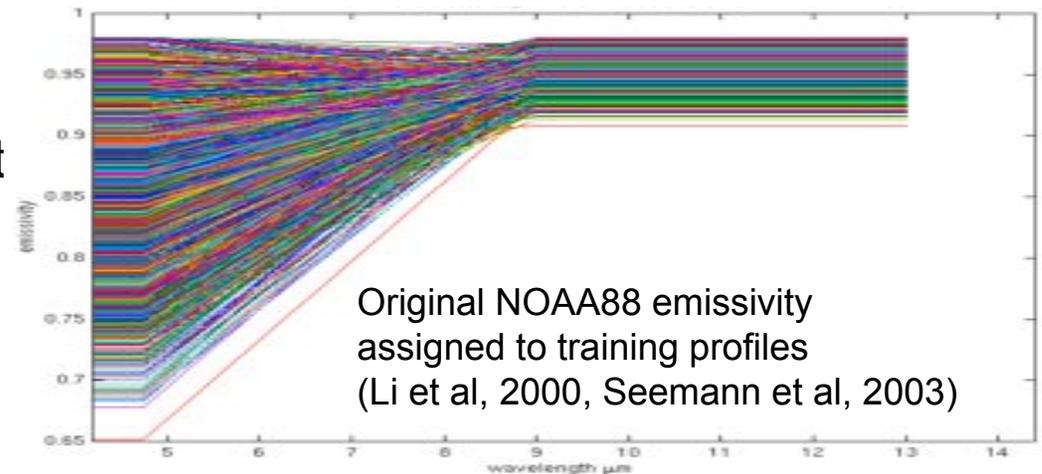
Motivation: Atmospheric retrieval algorithm (e.g. MOD07) requires a global set of profiles and corresponding surface data (Tskin, Psurf and surface emissivity).

We need:

A gridded, global surface emissivity database at high spectral and high spatial resolution

We have:

- **MODIS MOD11** emissivity, but only 4 distinct wavelength regions (monthly data on 0.05 degree grid (missing values))
- **Laboratory measurements** (UCSB, Dr. Wan, MODIS LT) of emissivity at high spectral resolution, but not necessarily representative of the emissivity global ecosystems as viewed from space

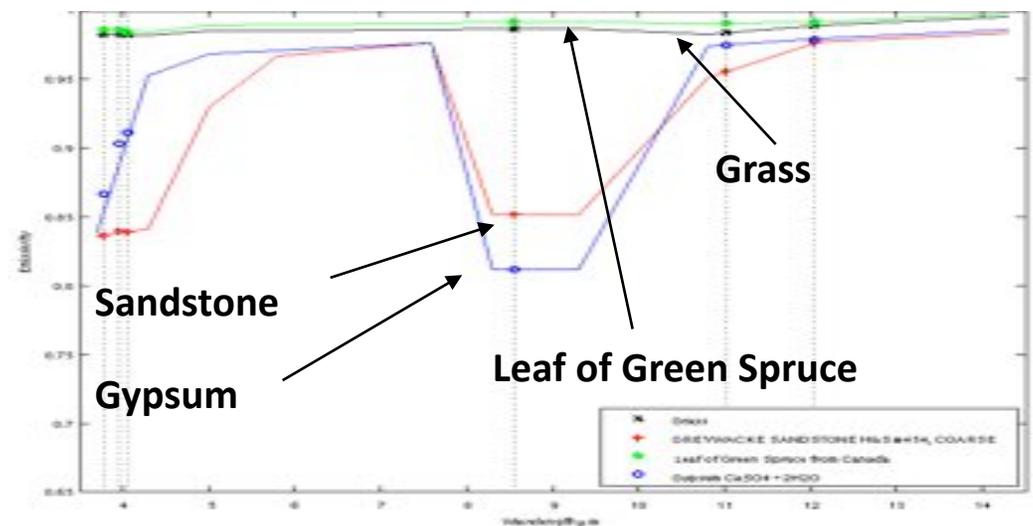
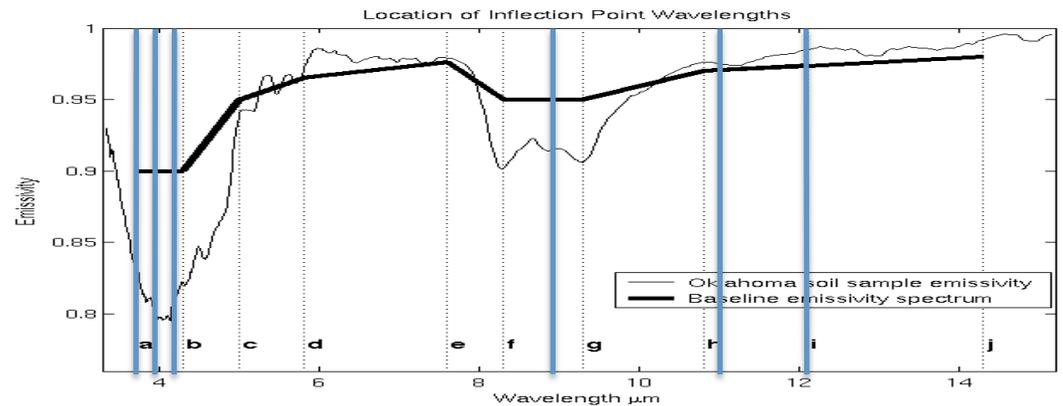


# Moderate Spectral Resolution DB: Baseline Fit Approach (Seemann)

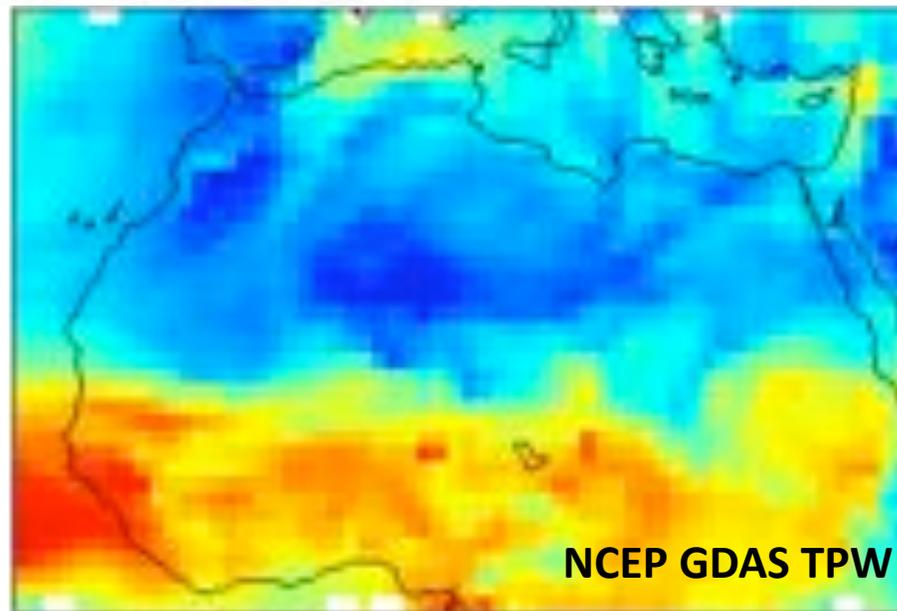
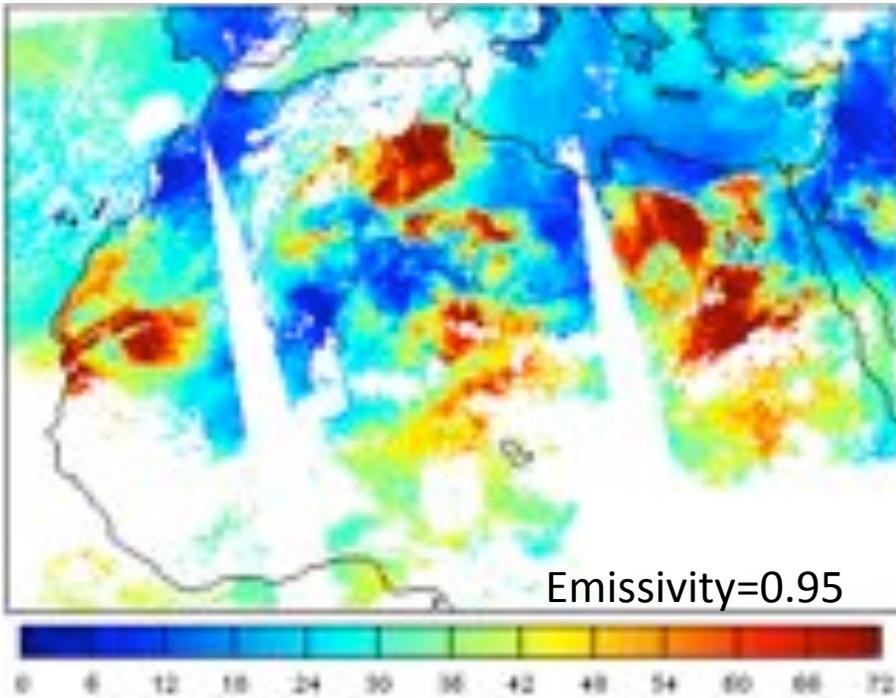
- **Input data:** MODIS MYD11
- The baseline fit method based on a **conceptual model** developed from laboratory measurements of surface emissivity is applied to fill in the spectral gaps between the six emissivity wavelengths available from MYD11
- **10 hinge points** were chosen to capture as much of the shape of the higher-resolution spectra as possible between 3.7 and 14.3  $\mu\text{m}$ .
- Adjust a laboratory-derived “baseline emissivity spectra” based on the MOD11 values for every global latitude/longitude pair
- **Result:** a monthly global emissivity database at 10 wavelengths with 0.05 degree spatial resolution.
- **Reference:**

*Suzanne W. Seemann et al., 2008:  
J. Appl. Meteor. Climatol., Vol. 47, 108-123.*

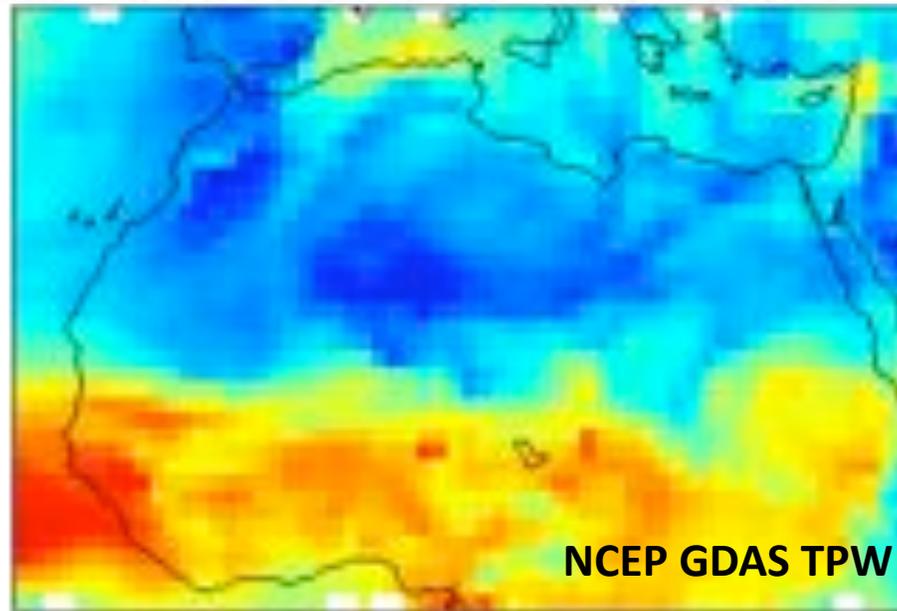
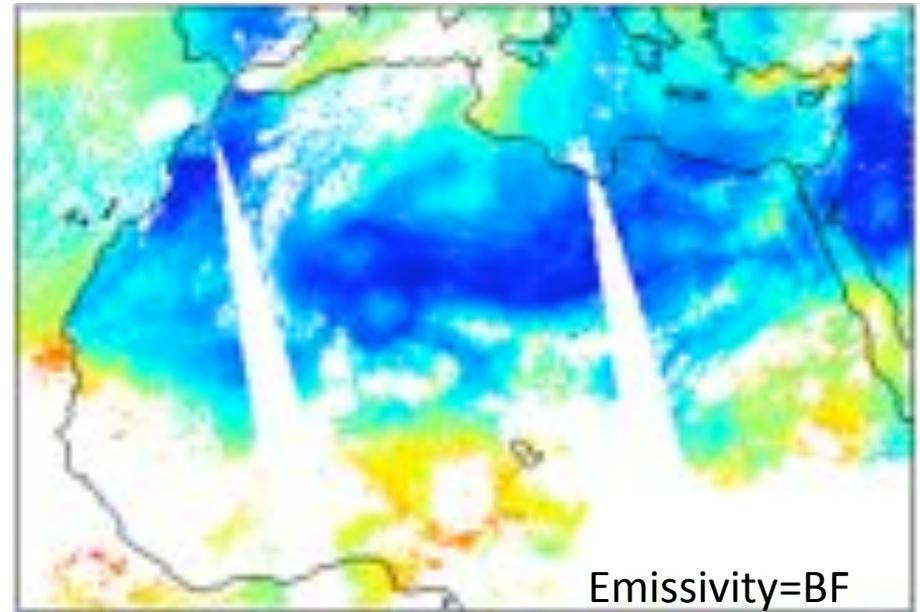
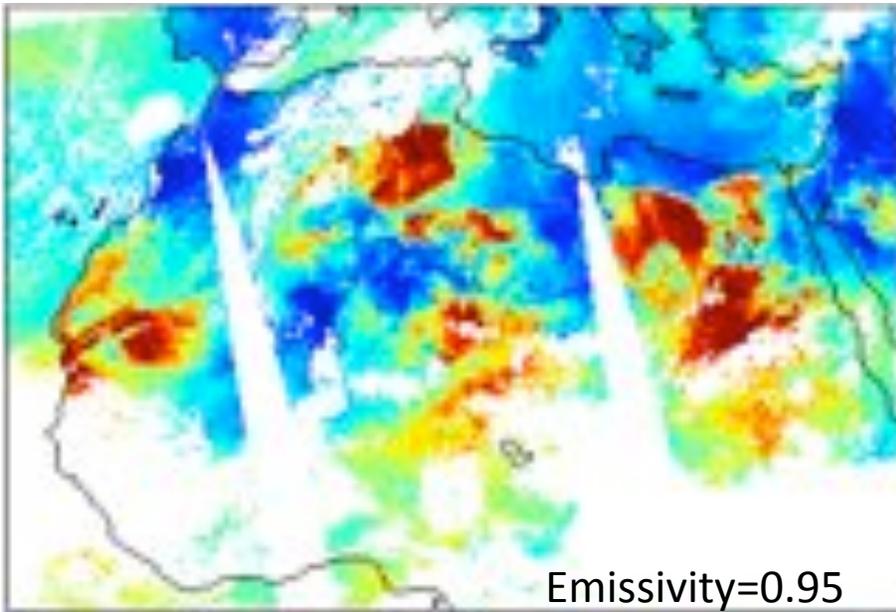
<http://cimss.ssec.wisc.edu/iremis>



Application: MOD07 TPW on 1 Aug 2005 at 2000 - 2320 UTC



Application: MOD07 TPW on 1 Aug 2005 at 2000 - 2320 UTC



# MOD07 Validation Efforts

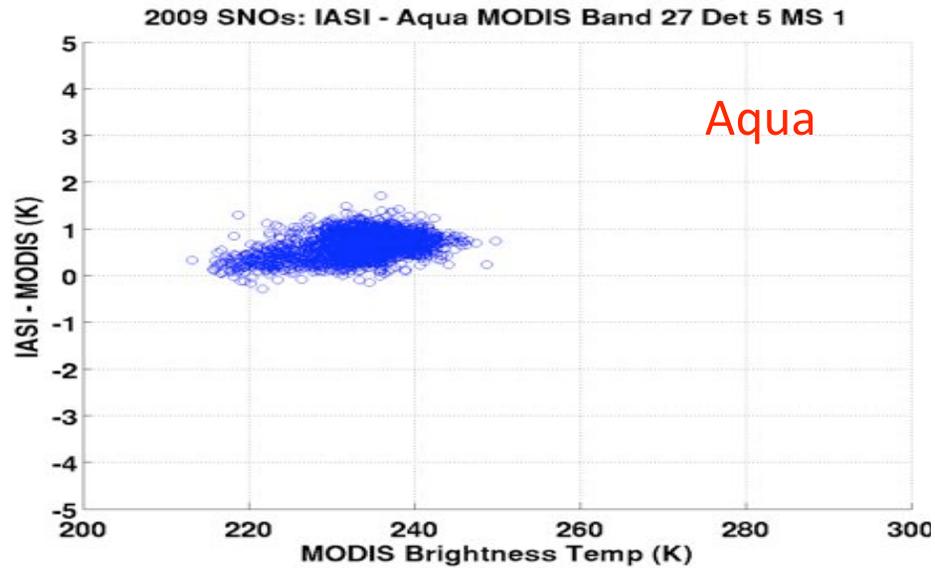
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- **TPW**: over the SGP ARM cart site with MWR and GOES
- **TOZ**: over Budapest, Hungary with Brewer and TOMS/OMI measurements
- **TPW & TOZ**: for selected global days with TOMS and AIRS data
- **TPW & Tsurf** over 3 locations in Sahara desert in 2007 by Zhengming Wan, ERI, University of California, Santa Barbara, CA

# SRF Investigation using IASI – MODIS BT Comparison for 2009

by C. Moeller, G. Quinn and D. Tobin

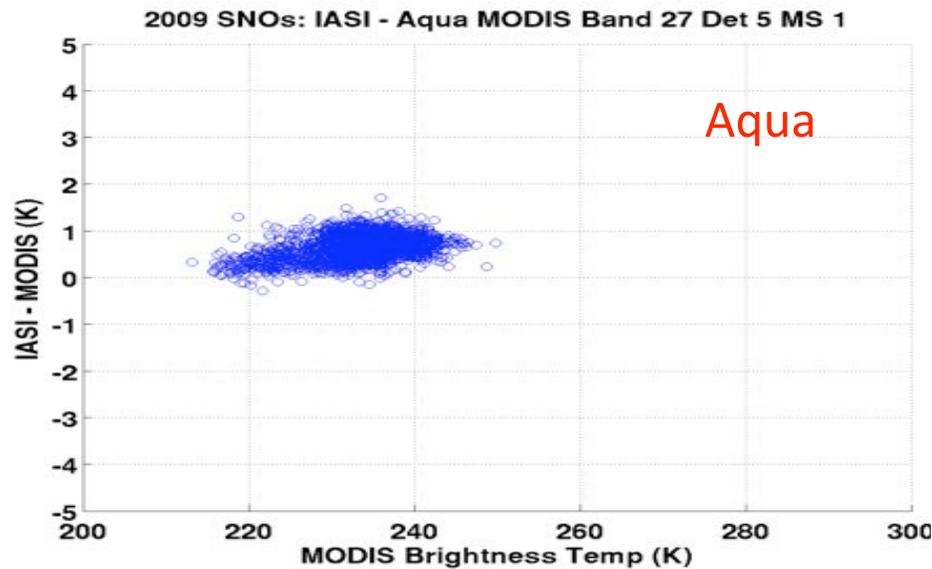
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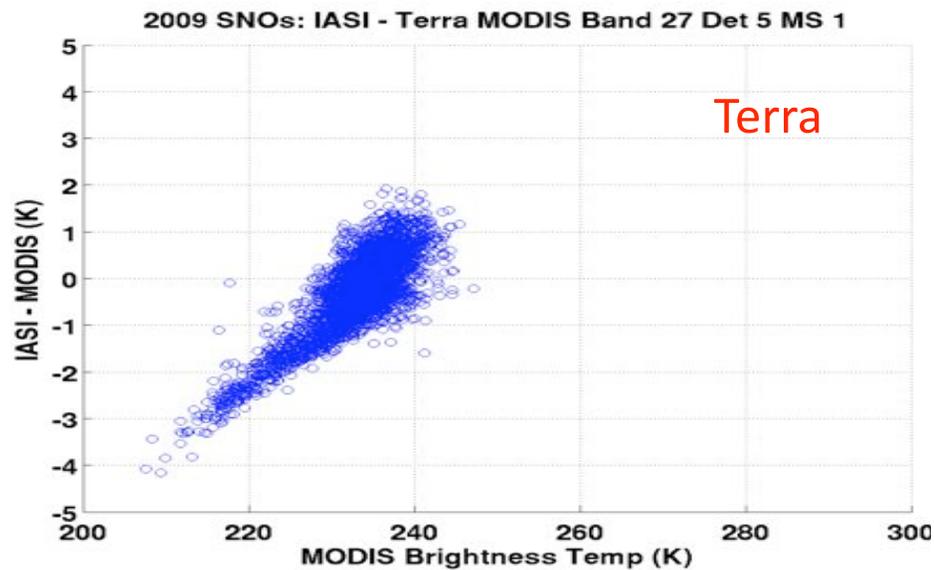
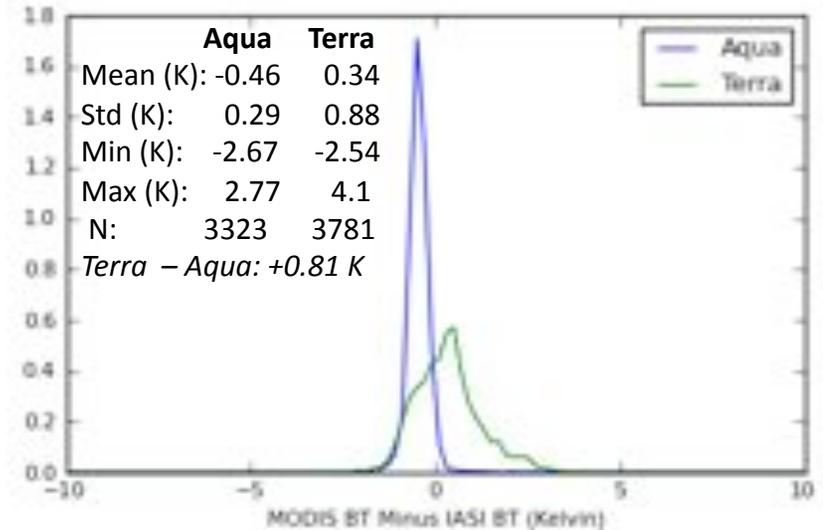
**Band 27**

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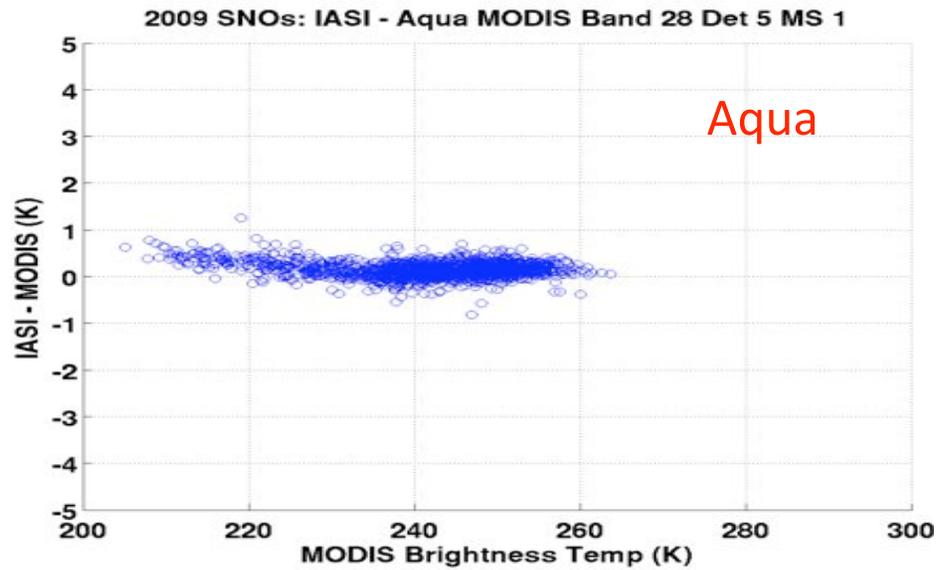
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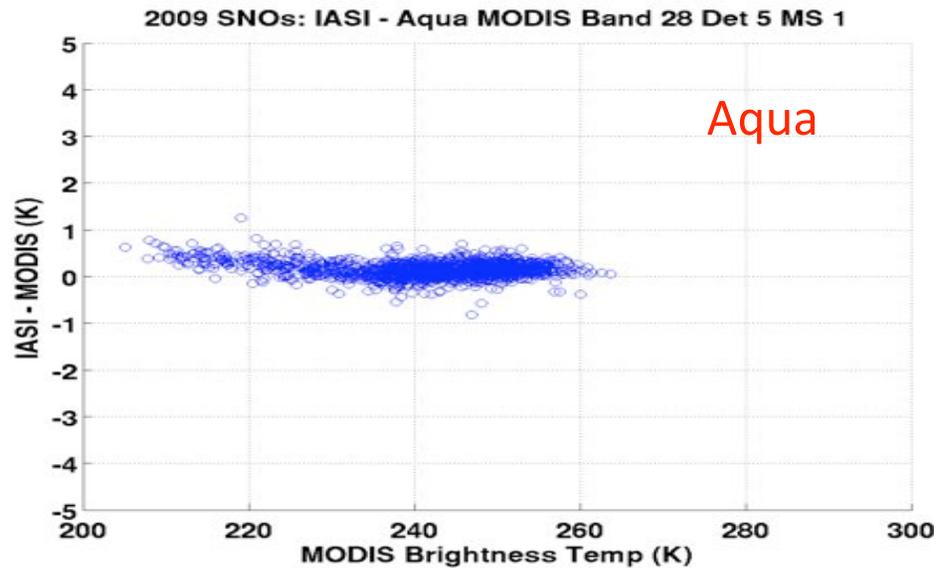
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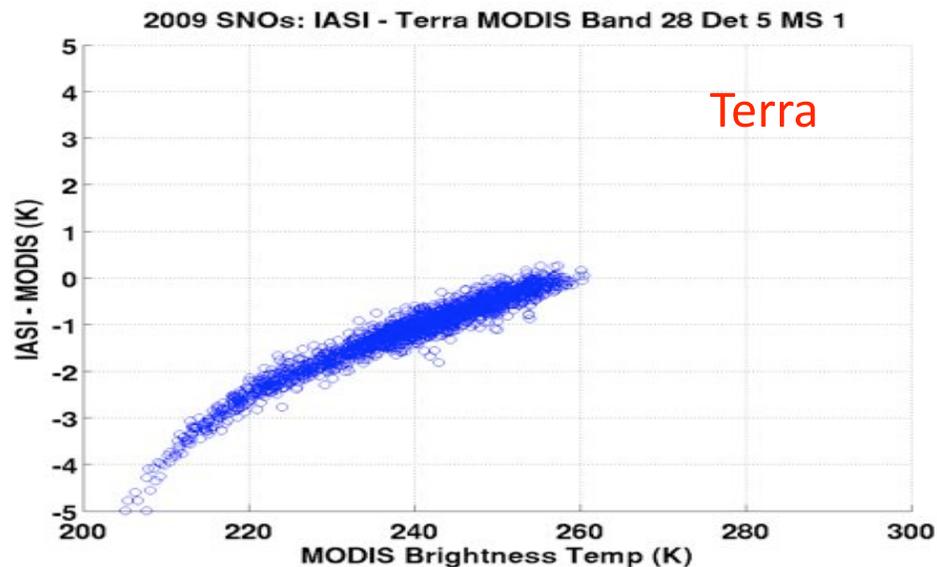
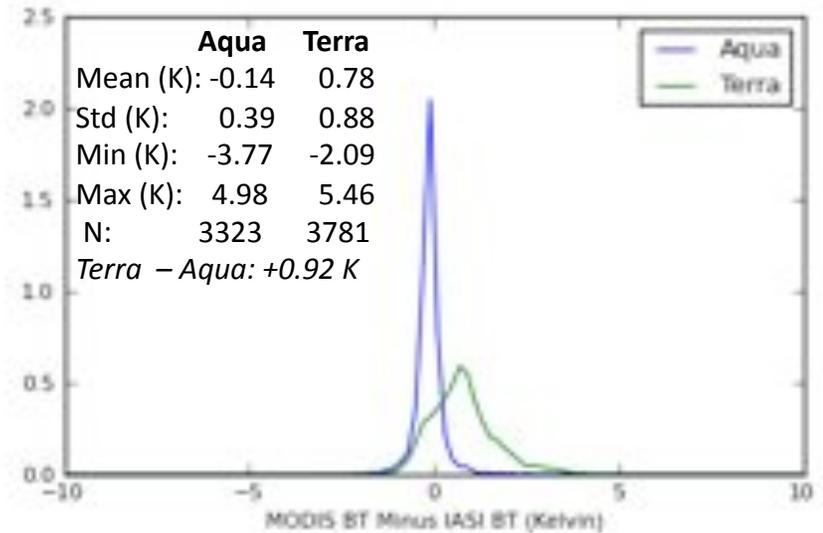
**Band 28**

# SRF Investigation using IASI – MODIS BT Comparison for 2009

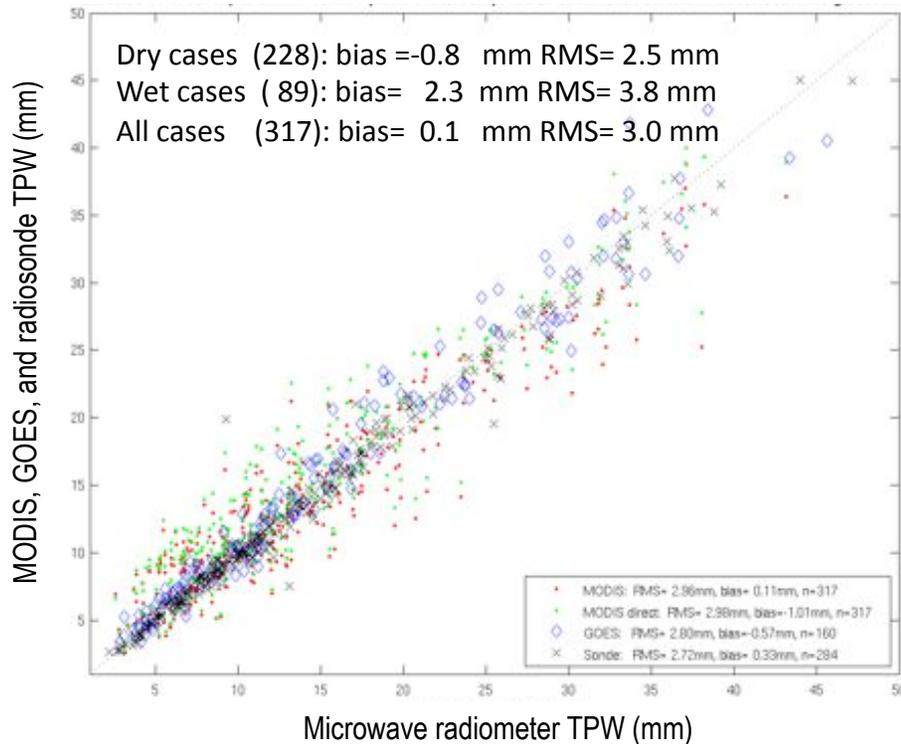
by C. Moeller, G. Quinn and D. Tobin



**Band 28**

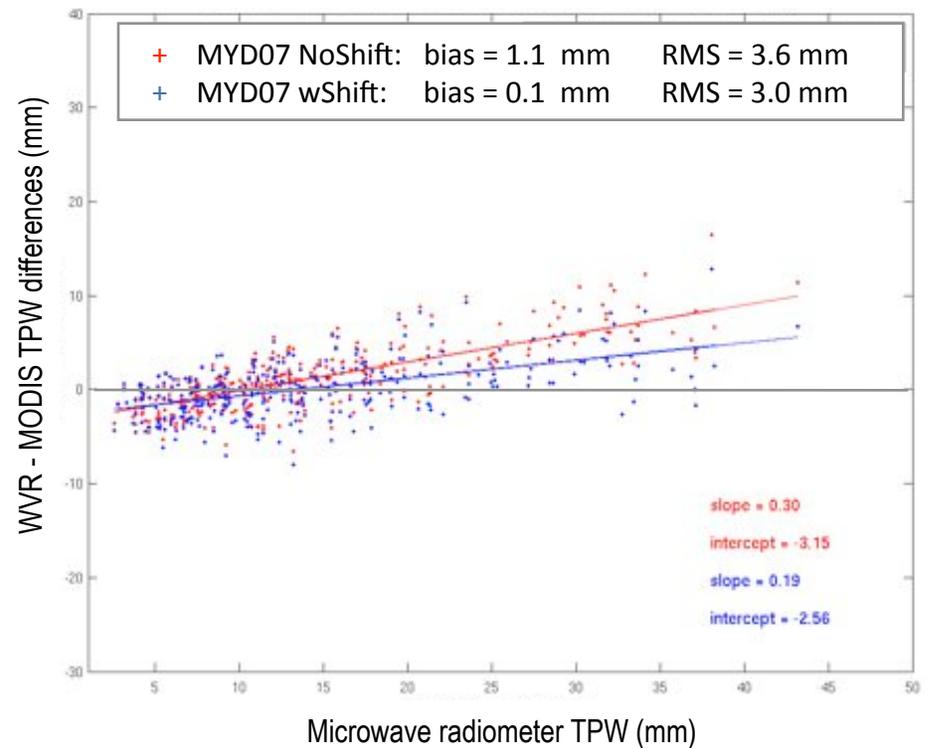
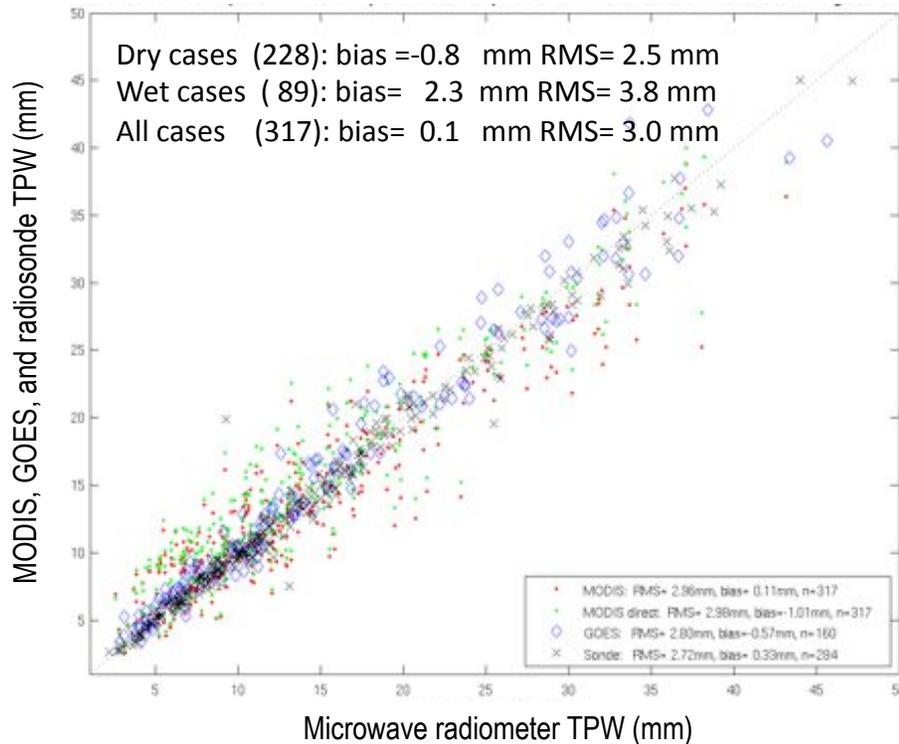


# MODIS (Aqua) TPW comparison at the SGP Cart Site



Comparison of total precipitable water (mm) at the ARM SGP site from Aqua MODIS (red), GOES-8 and -12 (blue), and radiosonde (black), with the ground-based ARM SGP microwave radiometer for 317 clear sky cases from 4/2001 to 8/2005.

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# The impact of the Aqua H2O/CO2 channel spectral shifts on MYD07 TPW over the SGP Arm cart site

MOD07 versions	SRF shift	DRY (TPW<15mm) (228)		WET (TPW >=15mm) (89)		ALL (317 cases)	
		Bias	RMS	Bias	RMS	Bias	RMS
Aqua Col 5.2	No	-0.4	2.2	3.6	5.1	0.8	3.3
Aqua Col 6	No	-0.2	2.3	4.6	5.7	1.1	3.6
Aqua Col 6	Yes	-0.8	2.5	2.3	3.8	0.1	3.0

MOD07 versions	SRF shift	DRY (TPW<15mm) (217)		WET (TPW >=15mm) (128)		ALL (345 cases)	
		Bias	RMS	Bias	RMW	Bias	RMS
Terra Col 5.2	No	-0.7	2.0	1.1	3.2	-0.04	2.5
Terra Col 6	No	-0.7	2.0	1.9	4.0	0.3	2.9

					Bias	RMS
GOES					-0.1	2.0 (171)
Radisonde					0.6	1.3 (282)

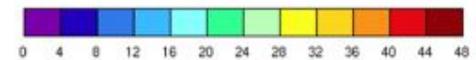
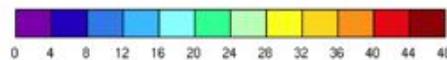
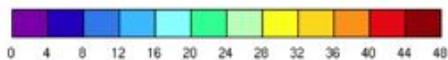
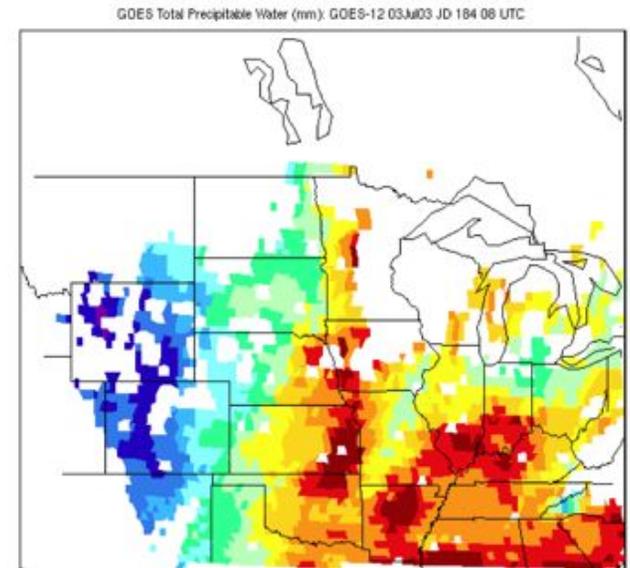
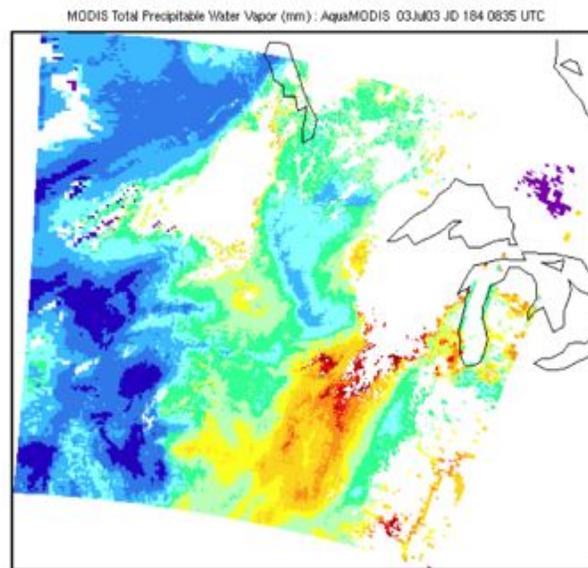
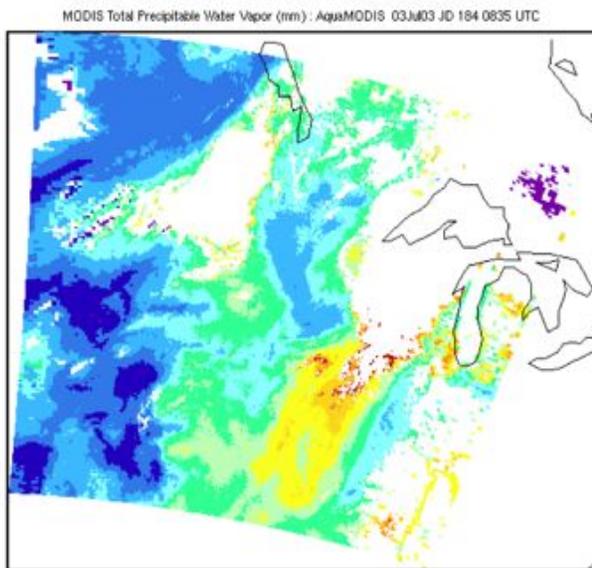
# The impact of the Aqua H2O/CO2 channel spectral shifts on MYD07 TPW over the SGP Arm cart site

TPW field at July 3, 2003 at 0800 UTC

MYD07 TPW no shifts

MYD07 TPW with shifts

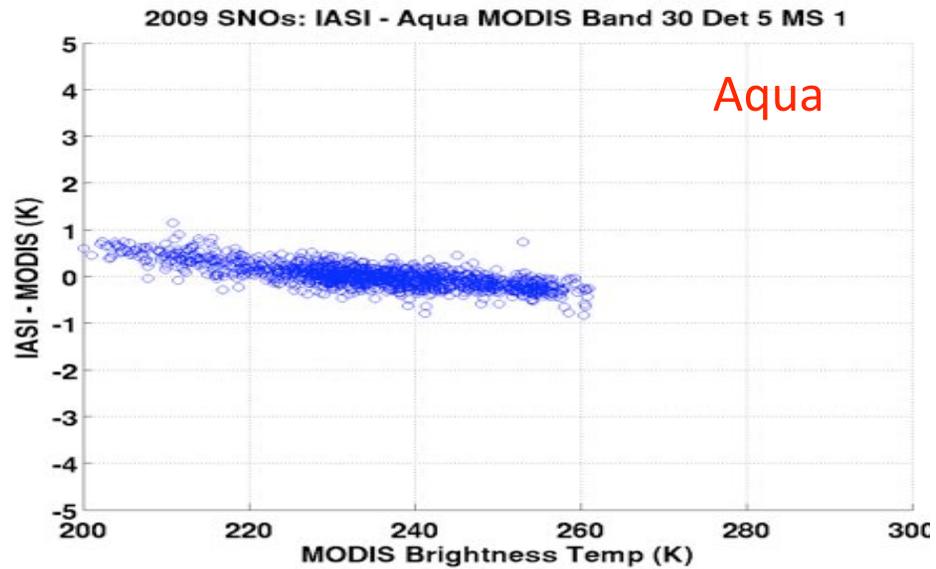
GOES TPW



# SRF Investigation using IASI – MODIS BT Comparison for 2009

by C. Moeller, G. Quinn and D. Tobin

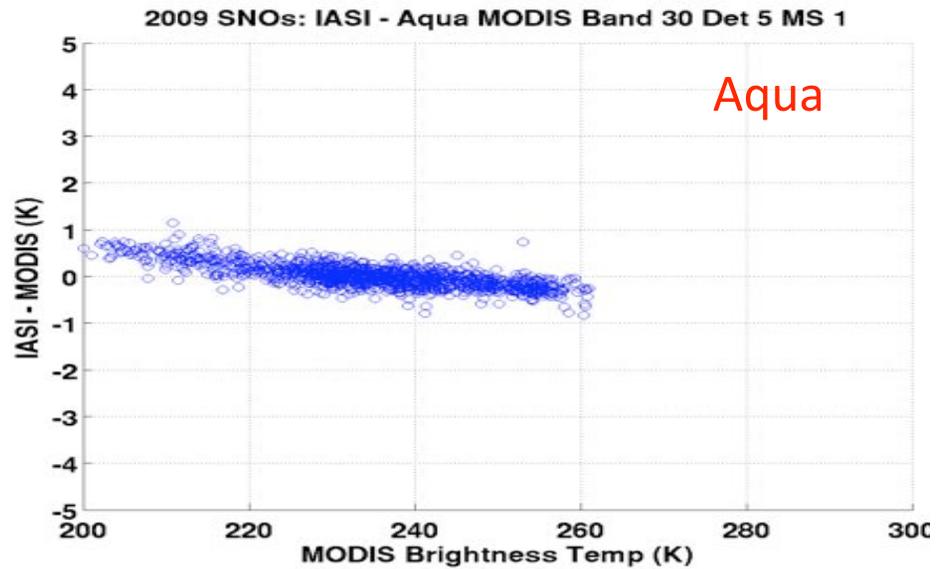
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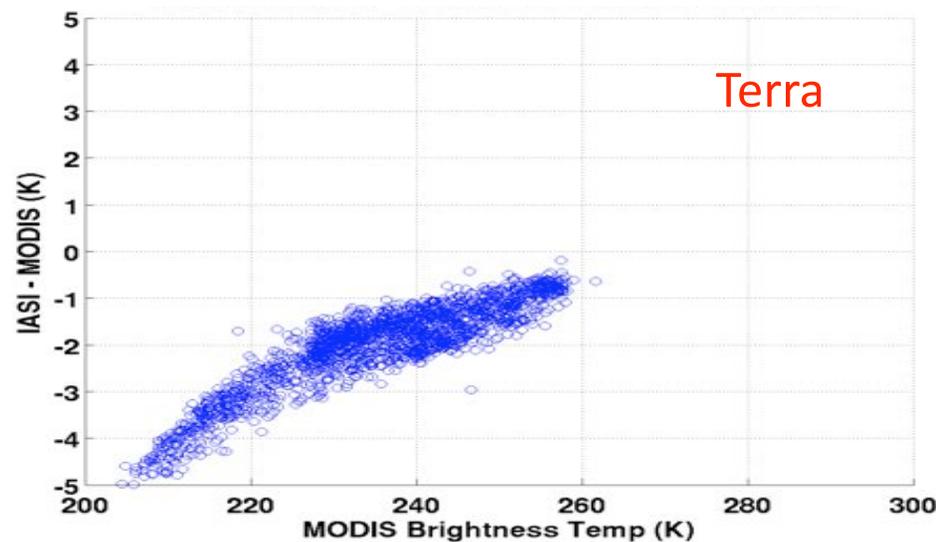
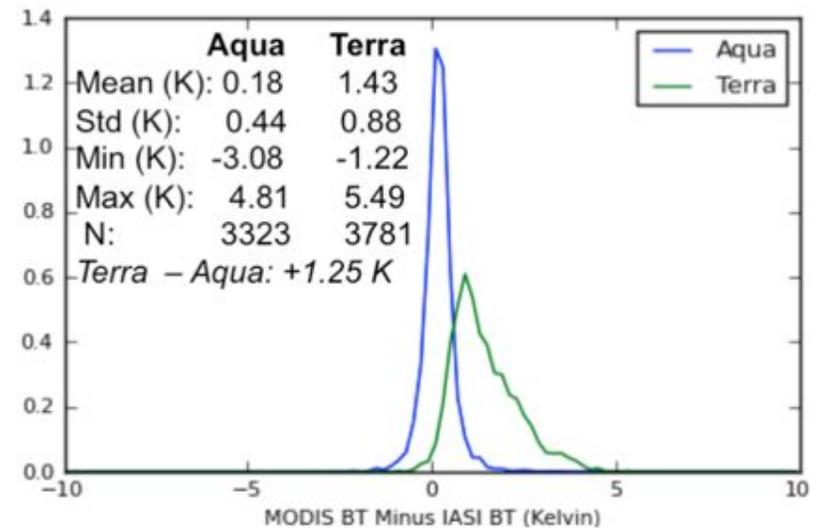
**Band 30**

# SRF Investigation using IASI – MODIS BT Comparison for 2009

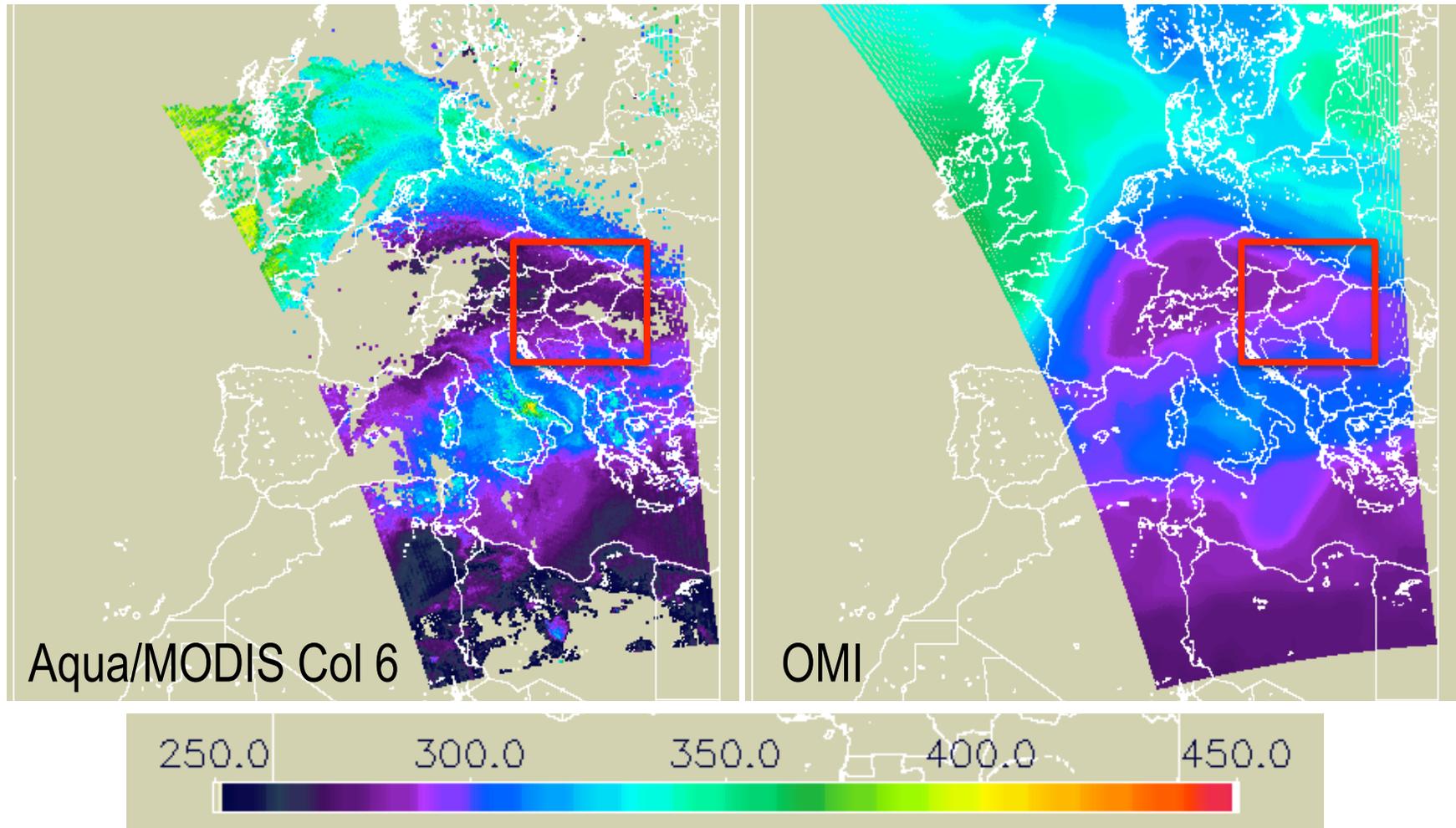
by C. Moeller, G. Quinn and D. Tobin



**Band 30**

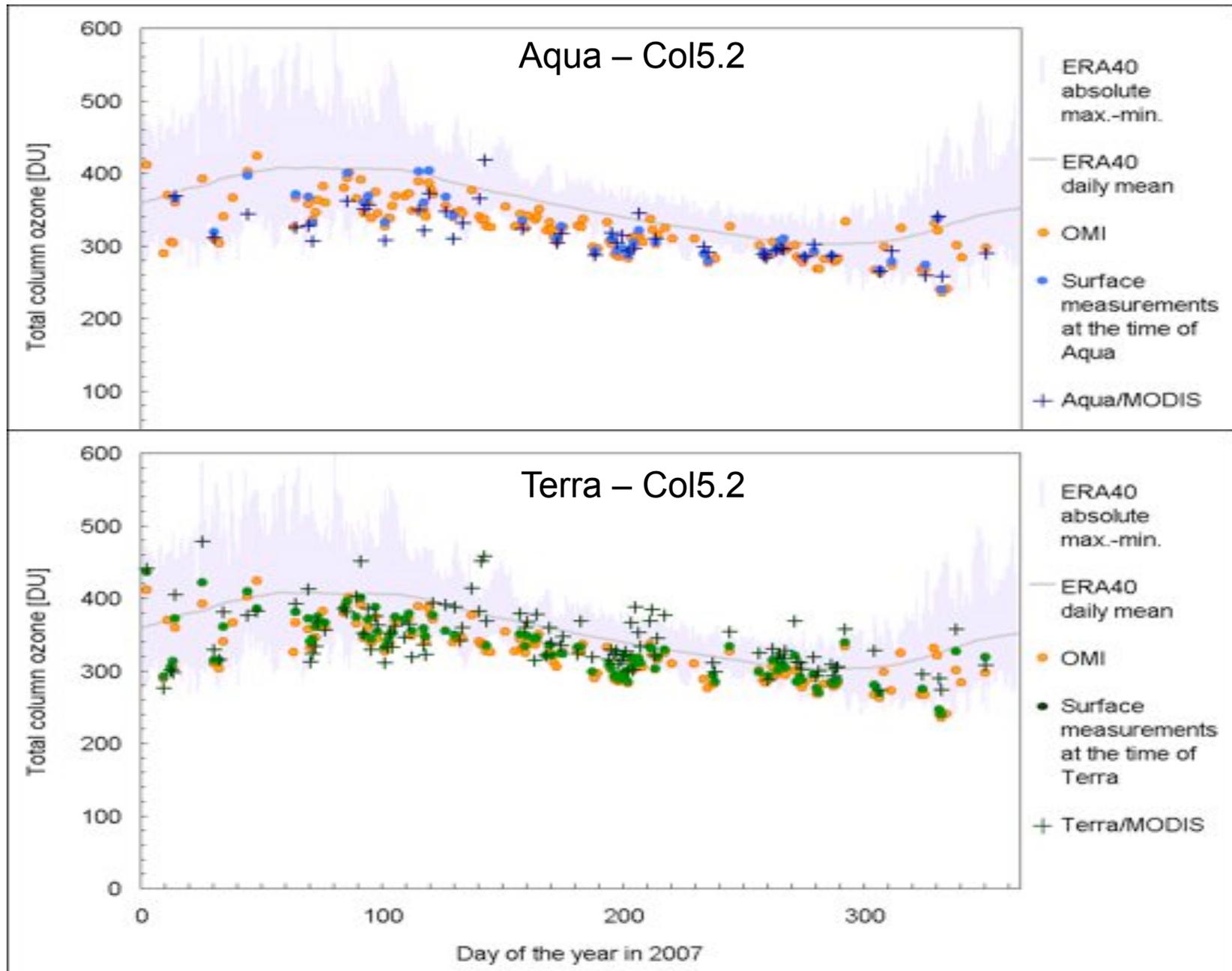


# Total Ozone on 07.08.2007 at 12:18:55 UTC

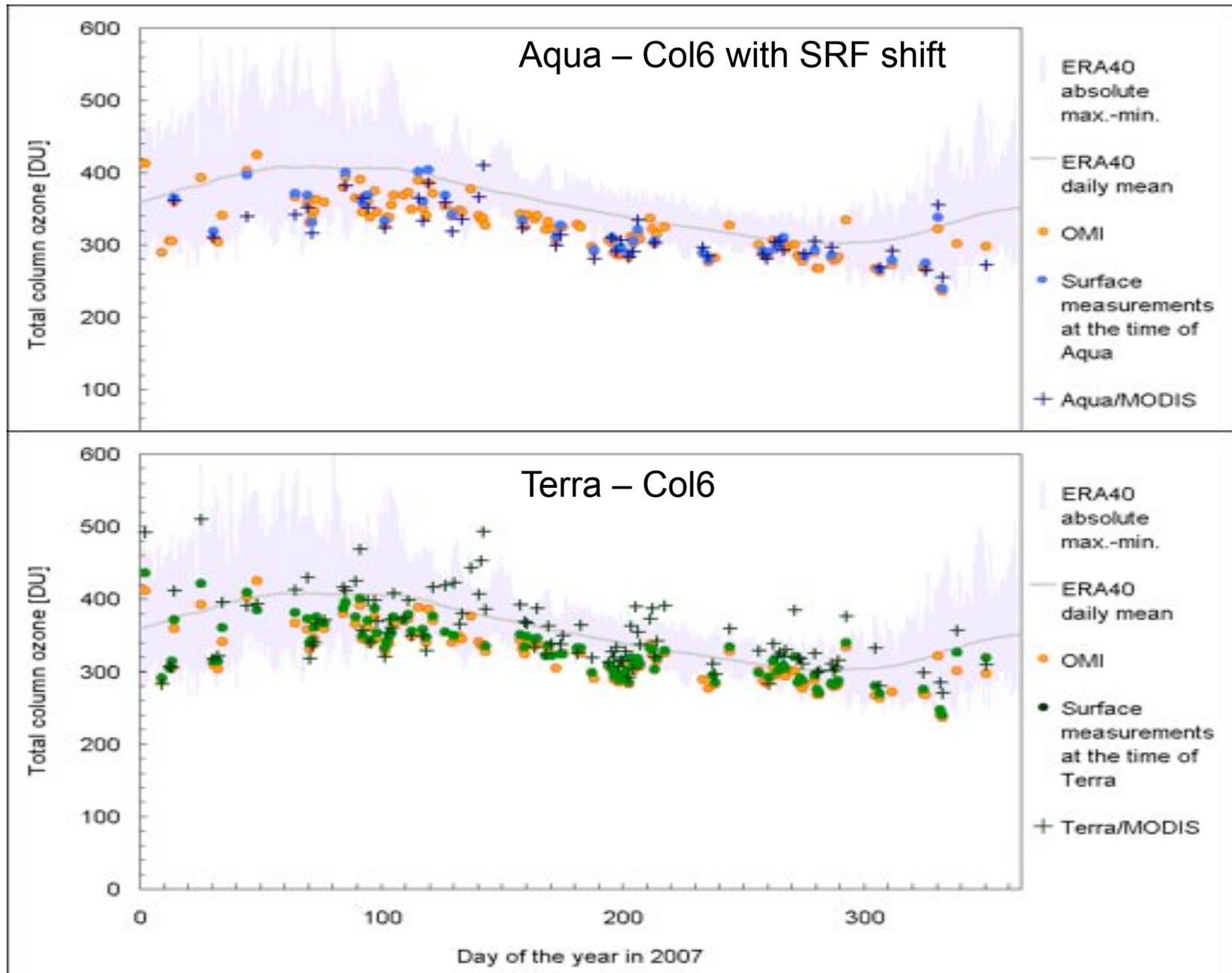


To date no Band 30 SRF shifts have been applied for Total Ozone product derivation

# Time series of TOZ observations for 2007 over Budapest, Hungary



# Time series of TOZ observations for 2007 over Budapest, Hungary



# MOD07 TOZ vs. Brewer Ozone over Budapest, Hungary for 2007

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Satellite-based TOZ vs. Surface Brewer Measurements	Bias [DU]	Stdev [DU]	RMSE [DU]	R <sup>2</sup>
OMI at Terra overpass times	6.8	6.9	9.7	0.96
MOD07/Terra Collection 5.2	-16.8	20.0	26.1	0.69
MOD07/Terra Collection 6 without spectral shifts	-26.5	17.3	31.6	0.76
OMI at Aqua overpass times	0.6	7.5	7.6	0.99
MYD07/Aqua Collection 5.2	6.0	20.8	21.6	0.81
MYD07/Aqua Collection 6 without spectral shifts	-1.2	17.6	17.7	0.83
MYD07/Aqua Collection 6 with spectral shifts	4.0	16.0	16.5	0.88

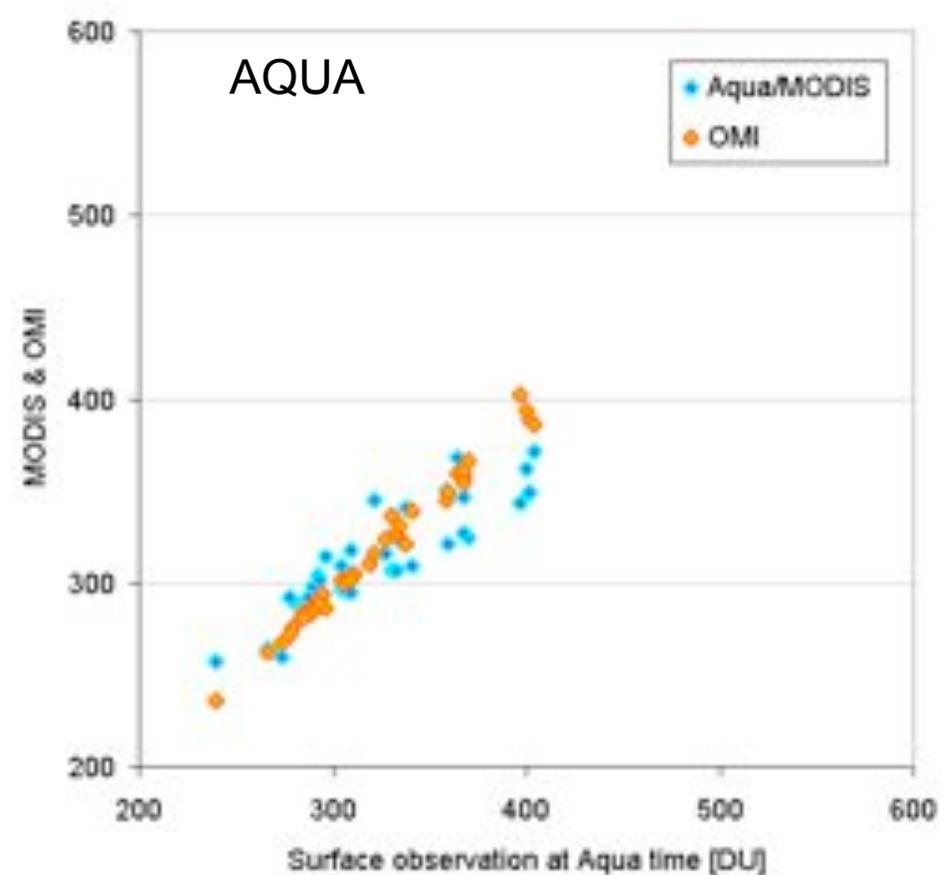
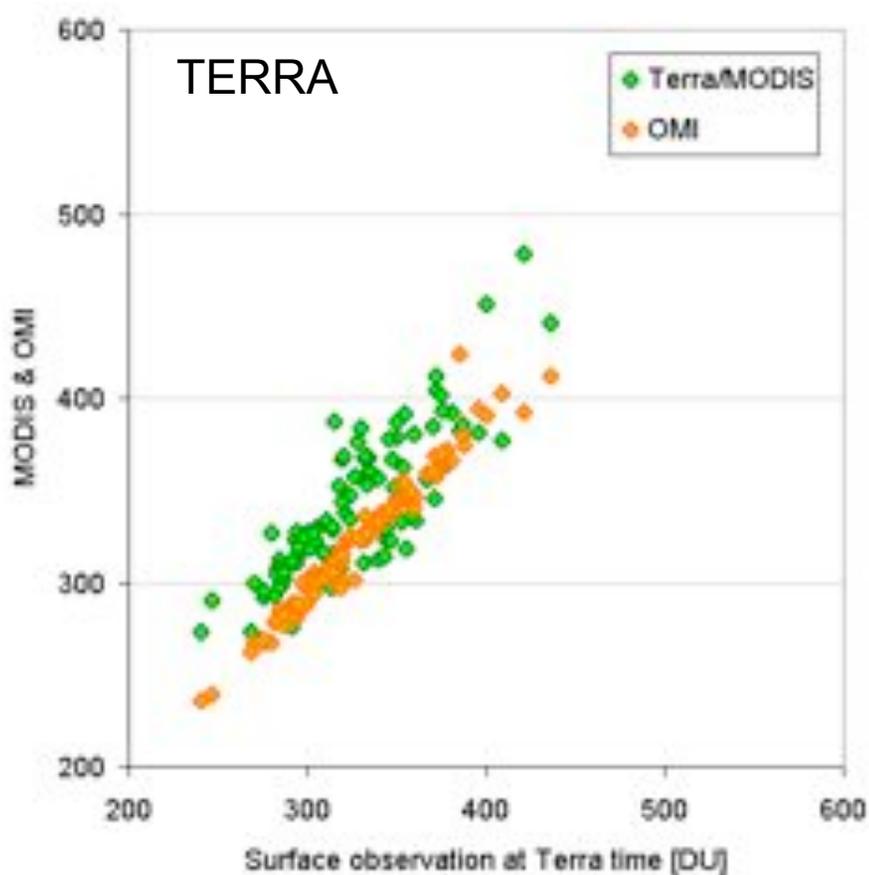
Terra case nb= 102  
Aqua case nb= 41

*The Brewer spectrophotometer derived TOZ measurements were provided by Zoltan Toth (Hungarian Met Service).*

# Scatter plot of satellite-based (MODIS and OMI) TOZ vs. ground-based Brewer Measurements for 2007 at Budapest, Hungary

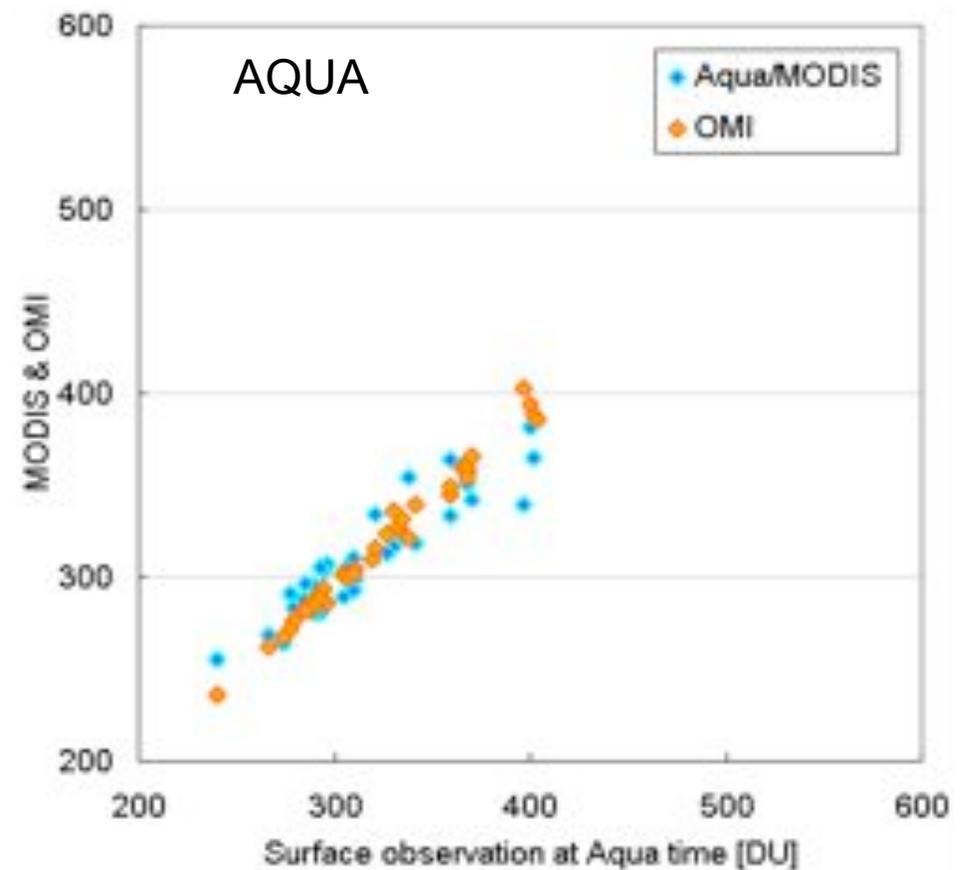
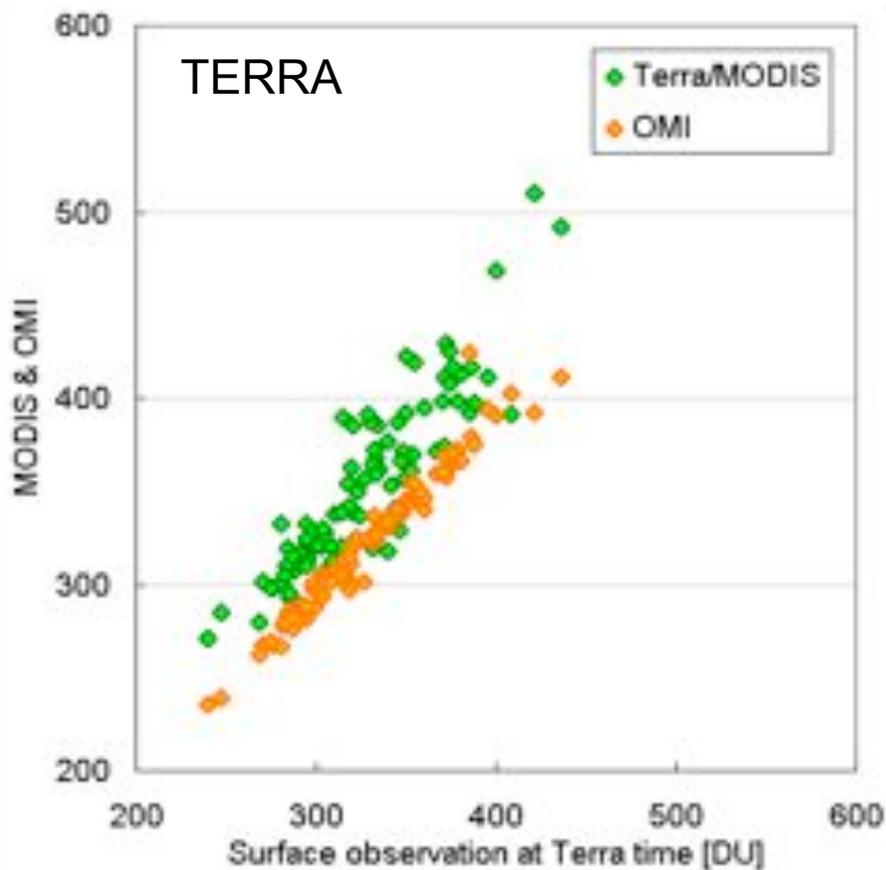
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## Collection 5

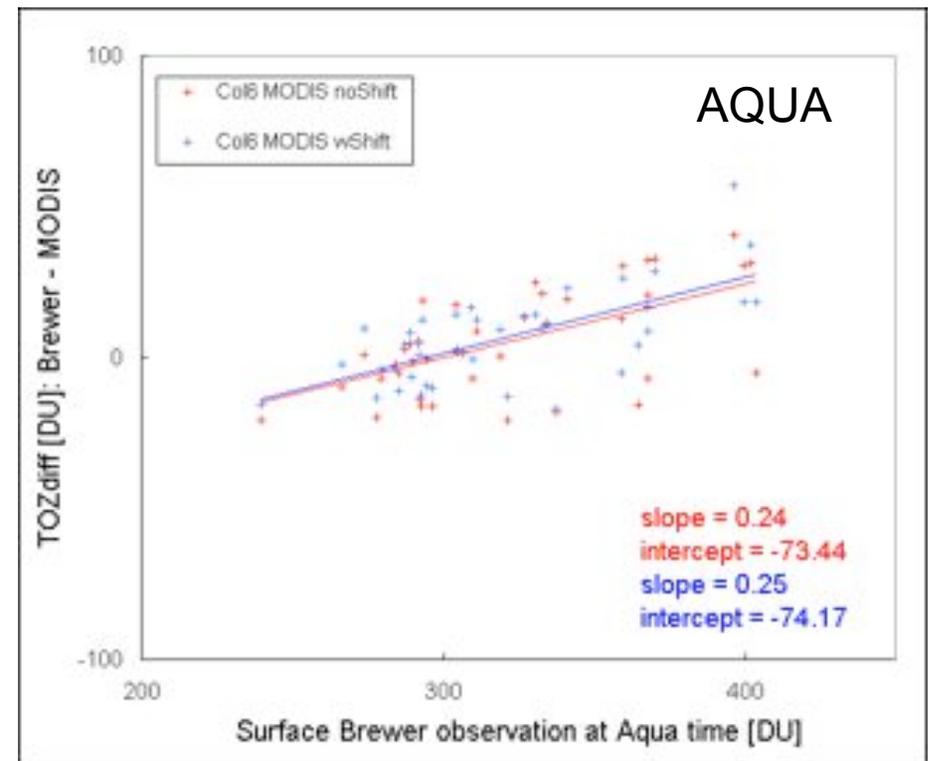
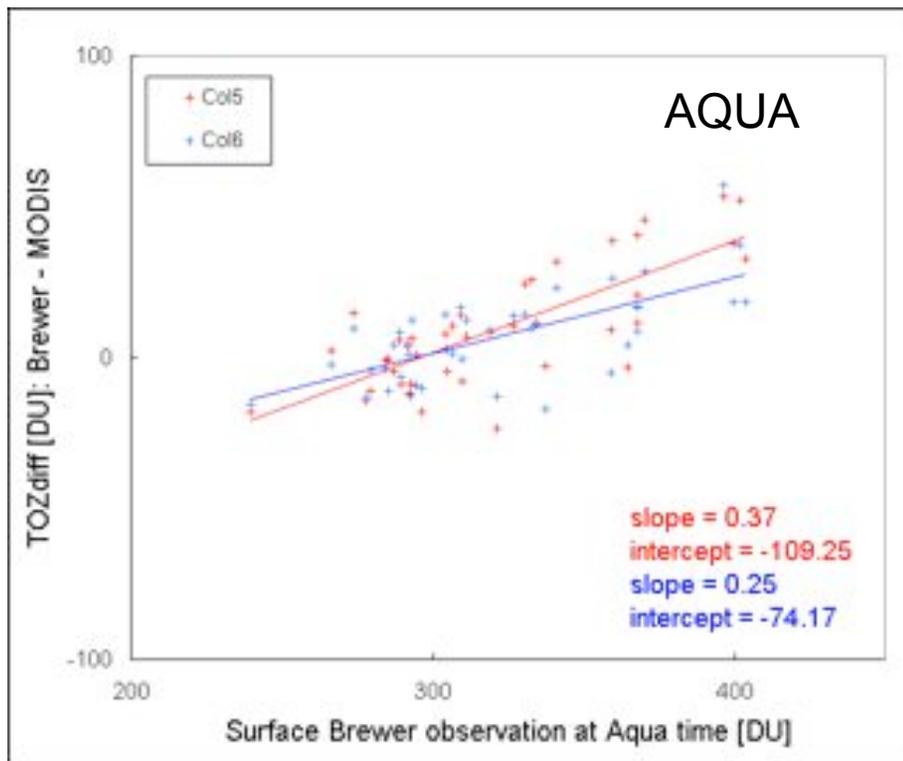


# Scatter plot of satellite-based (MODIS and OMI) TOZ vs. ground-based Brewer Measurements for 2007 at Budapest, Hungary

## Collection 6

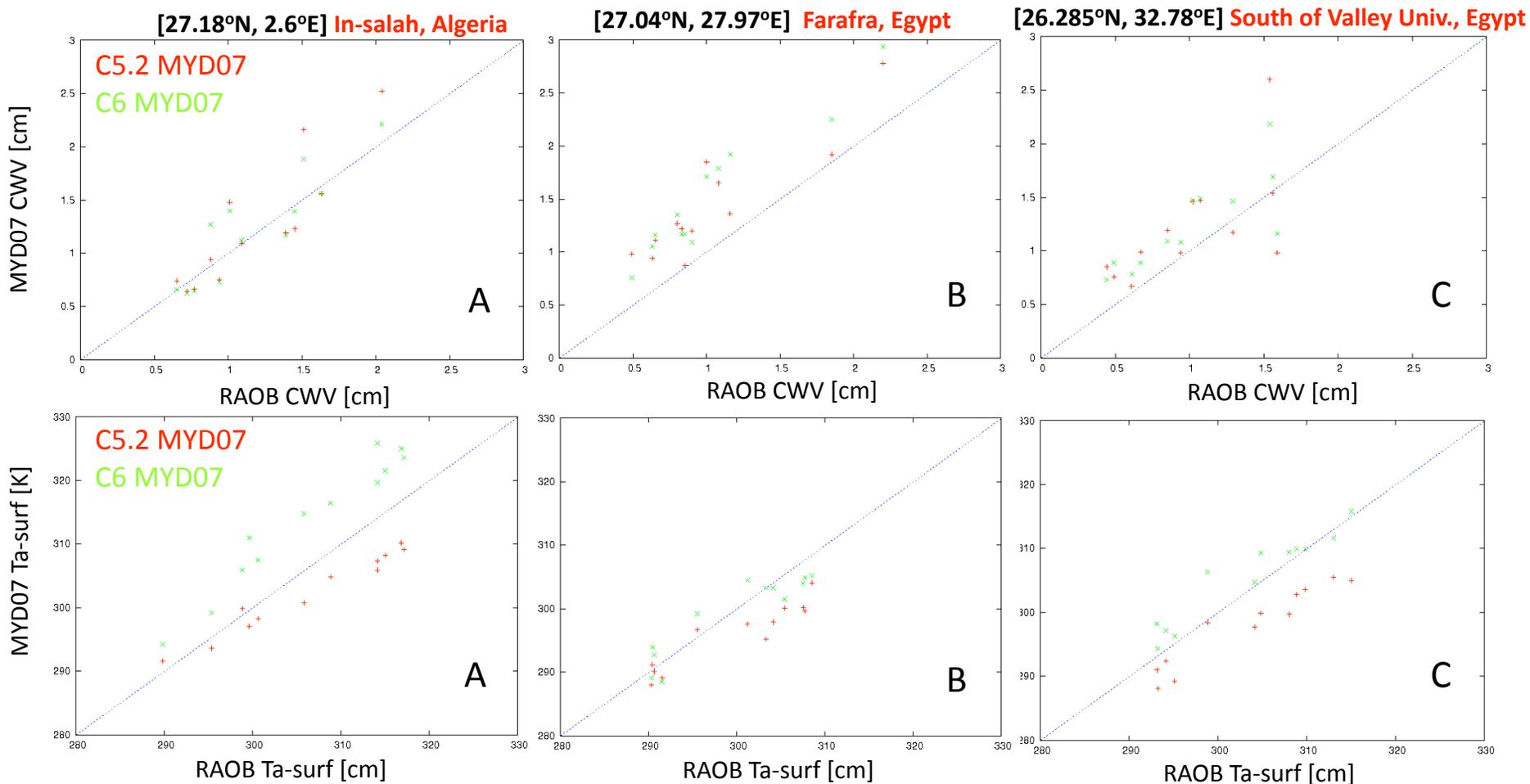


# TOZ bias dependence by the Ozone content



# Comparing the C5.2 and C6 MYD07 CWV and Ta-surf with RAOB over 2007

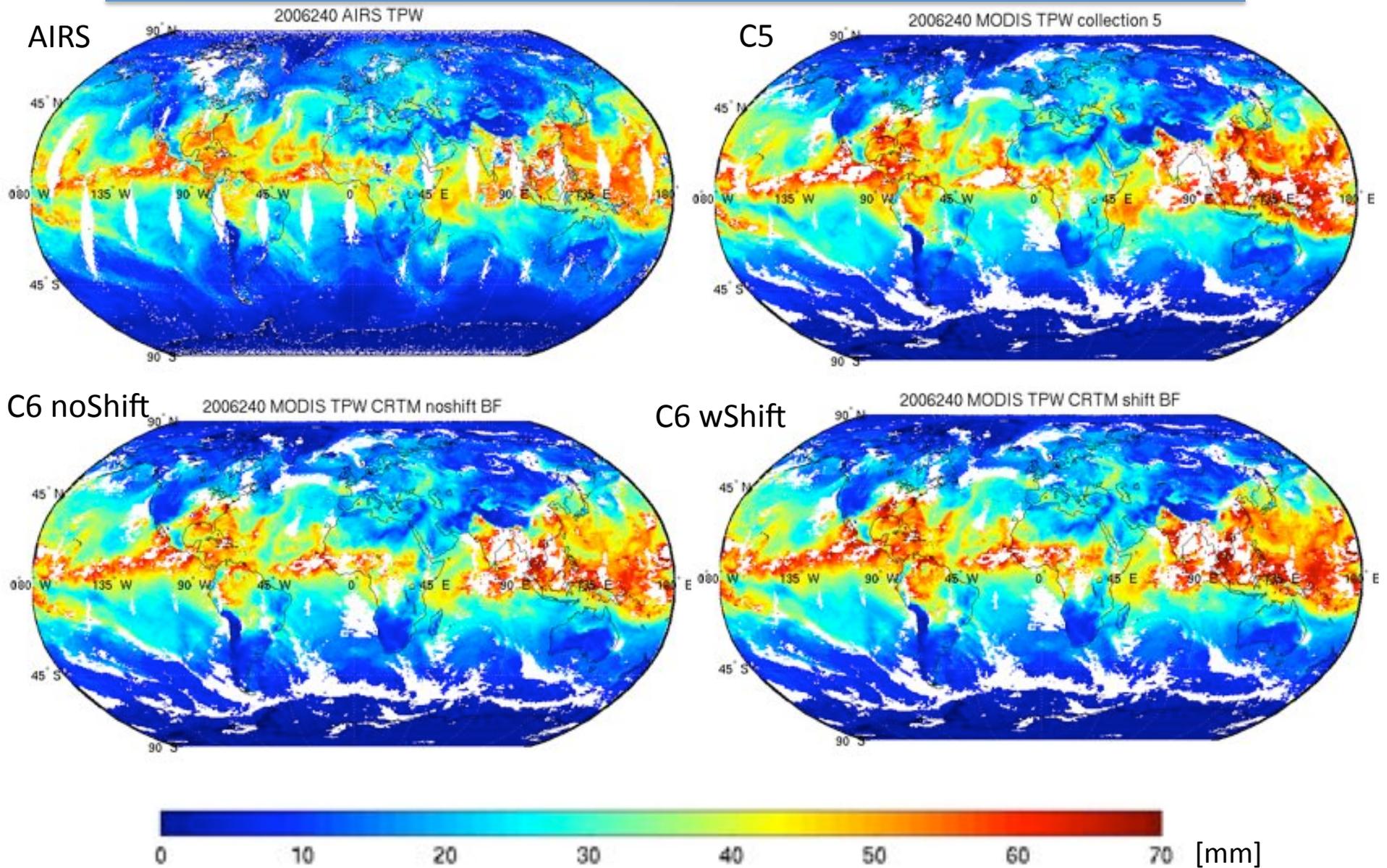
by Zhengming Wan, ERI, UCSB, CA wan@icess.ucsb.edu



- The TPW in the C5 MYD07 product is often significantly overestimated comparing to RAOB and the air temperature at the surface boundary layer is underestimated in North Africa regions
- cwv values in the new MYD07 are more close to the RAOB values in most cases (for Location A&C) but some cases in loc. B get worse.
- Ta-surf values in the new MYD07 are much better than the C5 values in loc. A but they become slightly overestimated at the three sites.
- Overall, the new MYD07 data are better than the C5 MYD07 data at these sites.

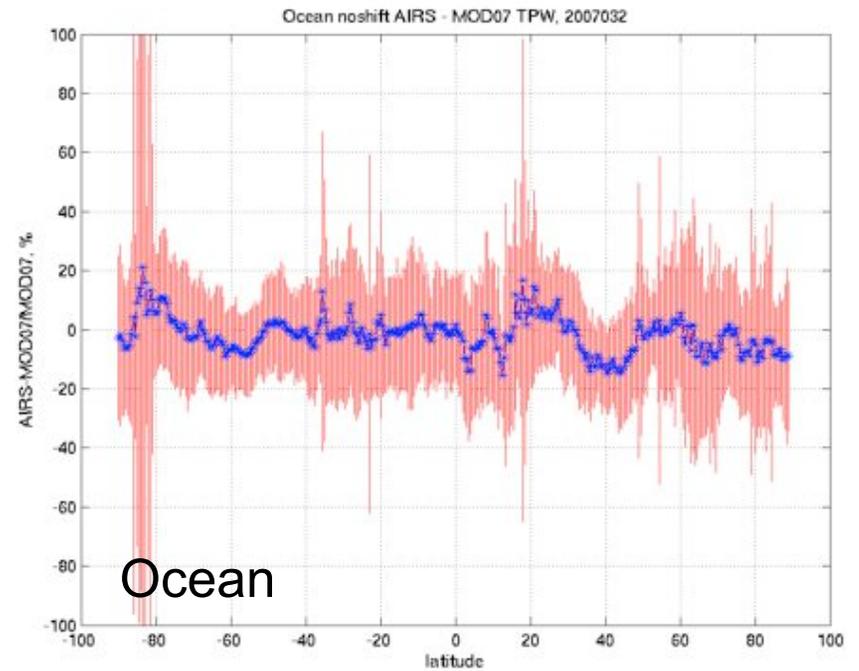
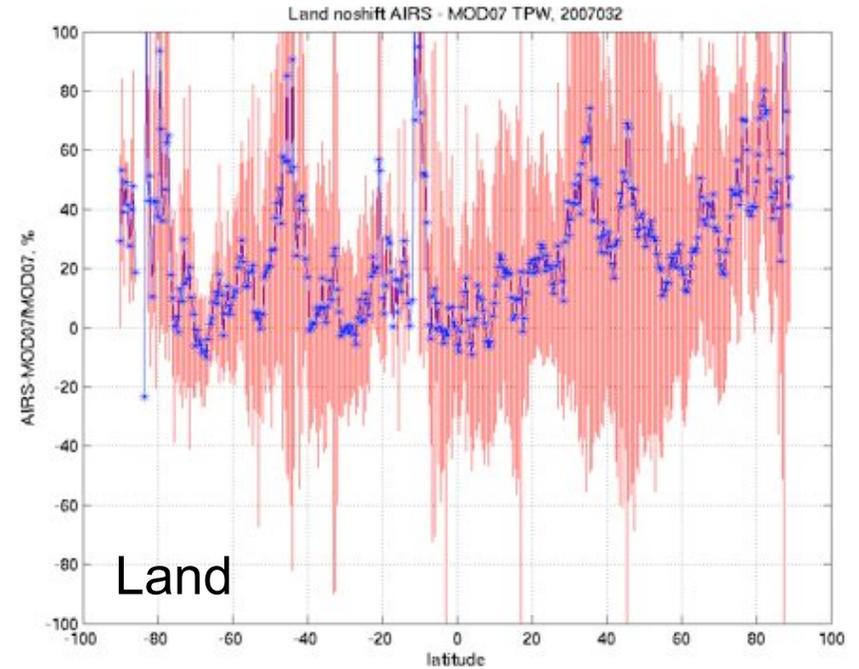
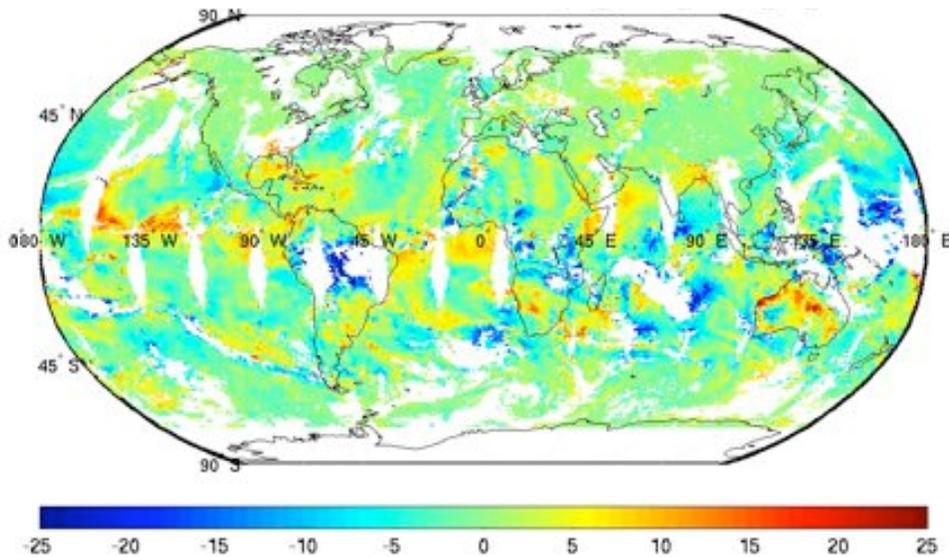
# Global TPW comparison with AIRS

on Aug 28, 2006



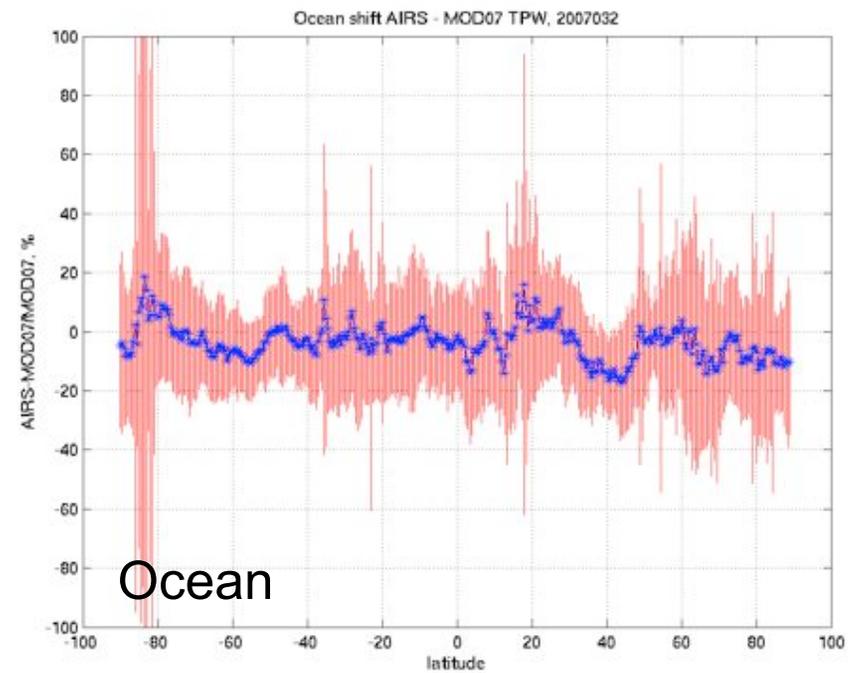
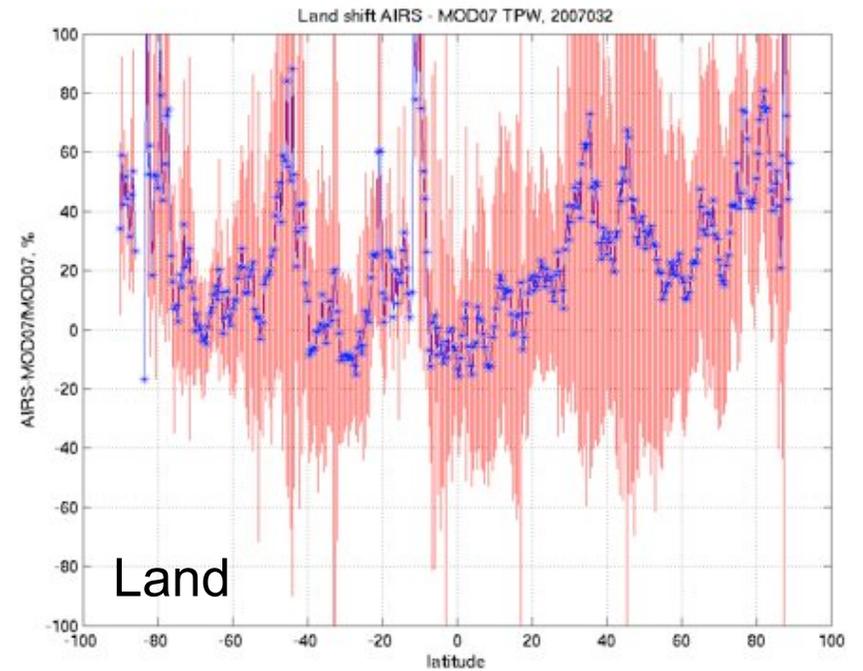
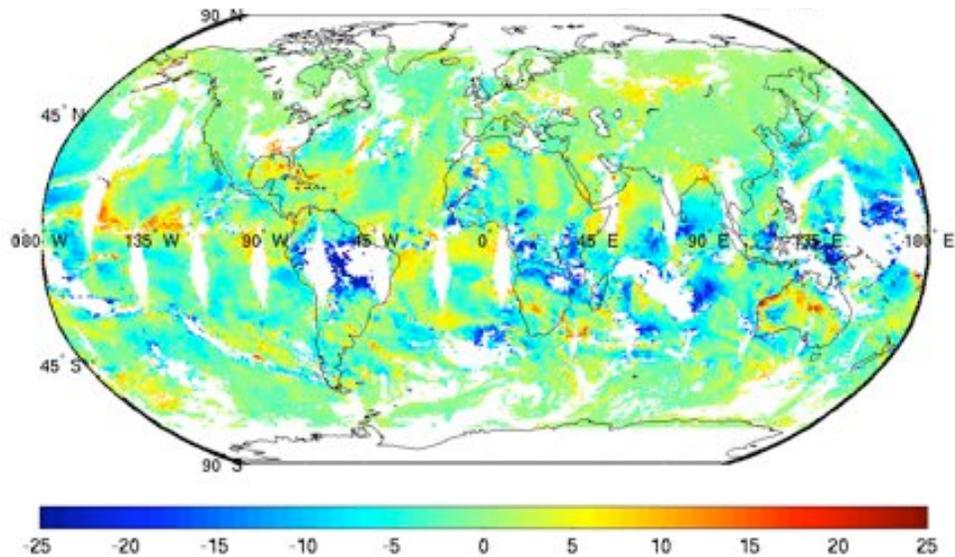
# Latitude dep. of AIRS-MOD TPW Differences on Feb 1, 2007

No SRF Shift  
Land:  $+0.1 \pm 5.2$   
Ocean:  $-0.7 \pm 4.7$



# Latitude dep. of AIRS-MOD TPW Differences on Feb 1, 2007

With SRF Shift  
Land:  $-0.9 \pm 5.8$   
Ocean:  $-1.5 \pm 4.8$



# Conclusions

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## **Validation over Sahara Desert by Dr. Wan:**

- TPW values in the new MYD07 are closer to the RAOB values in most cases with some exceptions.
- Ta-surf values in the new MYD07 are much better than the Col5 values in one site but they are slightly overestimated at the three sites.
- Overall, the new MYD07 TPW and Ta-surf data are better than the Col5 MYD07 data at the three Sahara desert sites.

## **TPW validation over the SGP cart site:**

- The application of Aqua spectral shifts shows big improvement of MOD07 TPW products particularly in the wet cases (TPW > 15mm) where the rms error was improved by 1.9 mm and the bias was reduced by 2.3 mm.

# Conclusions (cont.)

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## **TOZ validation over Budapest, Hungary:**

- The MOD07 TOZ comparison with the surface Brewer measurements and OMI TOZ shows that the new MOD07 collection 6 algorithm results in better correlation (less stdev) for Both Terra and Aqua. The Terra larger bias needs further investigation.

## **Global validation with AIRS and TOMS/OMI:**

- TOZ and TPW comparison with AIRS and TOMS/OMI are regularly monitored, but the results are inconclusive. The analytical comparisons need some further adjustments.  POSTER

## **Terra – Aqua SRF Investigations**

- IASI vs. MODIS BT differences show that Terra /MODIS H2O and O3 channels are more opaque while the CO2 channels are less opaque. Additionally, the IR channels (Band 20-30) show strong cold BT biases, which may be corrected by the adjustment of the calibration offset coefficients.

# Future Work

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- Investigate the impact of the corrected calibration offset coefficients and possible spectral H<sub>2</sub>O/CO<sub>2</sub> spectral shifts on the **TERRA/MOD07** products.
- Investigate the atmospheric profile products at one kilometer resolution.
- Study possibilities for switching from the synthetic statistical regression method to a physical retrieval algorithm.